The Benefits Of Sonic Drilling Techniques For Improved Recovery On Contaminated Sediment Sites

Peter M. Simon[1]

Mark DeLong[1] | Hugh Scott[2]

[1]Ann Arbor Technical Services, Inc. – Ann Arbor, Michigan, USA
[2]MPI Drilling – Picton, Ontario, Canada

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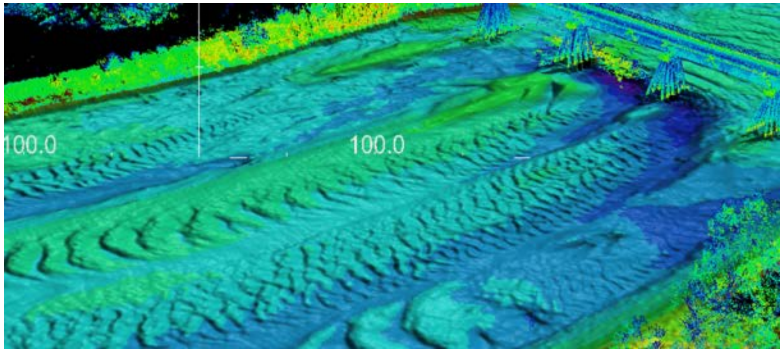
ANN ARBOR TECHNICAL SERVICES, INC.

Overview

- Sampling Objectives
- Sampling Devices and Challenges
- Common Sampling Problems
- Study DQOs and Dataset
- Data Summary
- Observations
- Benefits
- Suitability



Primary Objectives of Sediment Sampling

- **Obtain an undisturbed portion of the sediment bed that is intended to be representative of in-situ conditions**

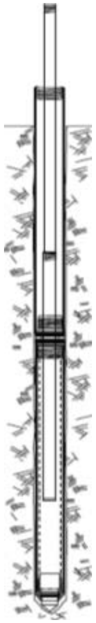
- **Accurate sampling is needed to properly define lateral and vertical extent of contamination**

- **Accurate definition of lateral and vertical extent of contamination is needed to properly evaluate risks and remedial alternatives**

Typical Sediment Coring Devices

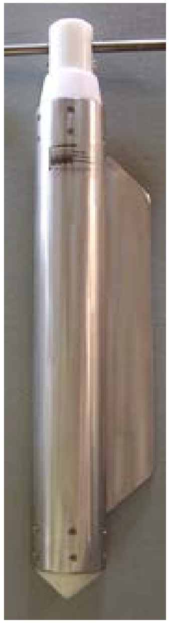
Check Valve*

GeoProbe**



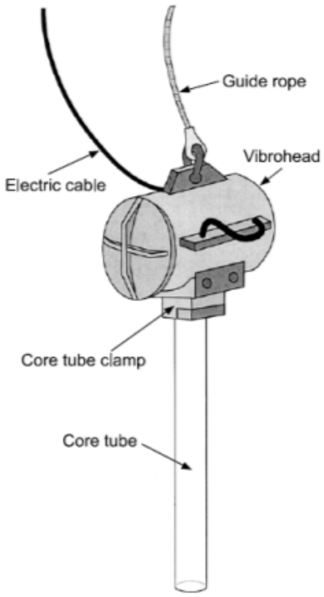
Piston**

Russian Peat Borer**



Soggy Bottom**

Vibracore***



Sonic***

Notes: * Manually advanced sampler that can be used mechanically for surface sediments.
** Manually advanced sampler.
*** Mechanically advanced sampler.

Common Sediment Coring Challenges

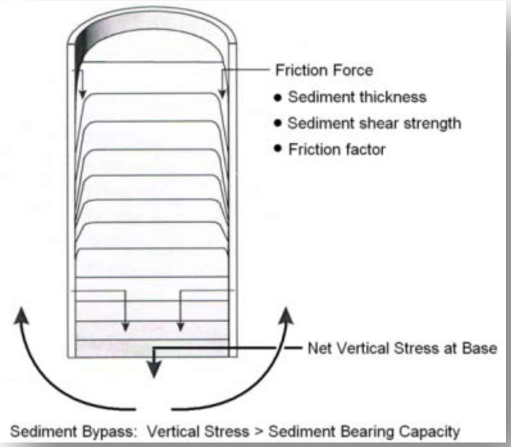
- Health and Safety
- Sample recovery in coarse sand formations
- Sample recovery of unconsolidated organic silts
- Presence of buried debris
- Cross contamination
- Limited access
- Variable water depths and flows
- Ice floes

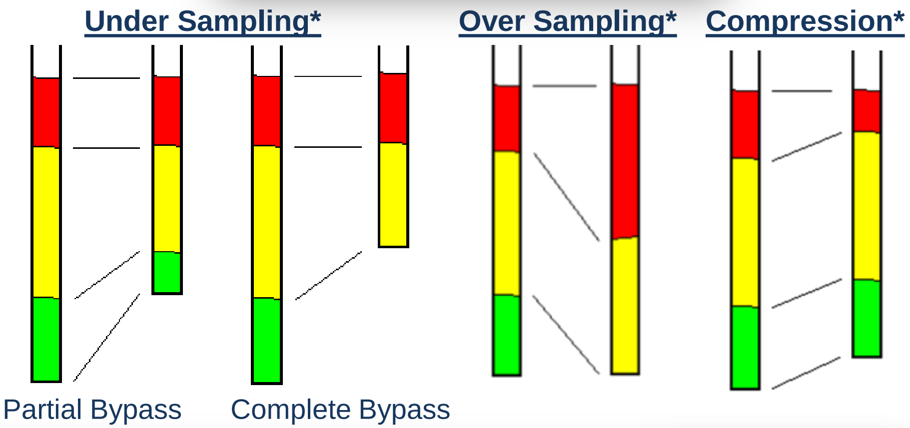
Core Recovery - A calculated value based on the measured length of core retrieved/measured length of core advanced.

Picture references: http://vibracore.com/pages/overview.html, http://www.acsu.buffalo.edu/~seanb/research-sean.html

Common Sediment Sampling Problems

- **Under Sampling – Partial Bypass**
  - Partial bypass of sediment around core sampler
  - Thinning of sediment layers in core sampler
- **Under Sampling – Complete Bypass**
  - Complete bypass of sediment around core sampler
  - Loss of sediment layer(s)
- **Oversampling**
  - Negative pressure "facilitates" sample intake
  - Expansion of interval(s)
- **Core Compression**
  - Requires discharge of pore water and consolidation of sediment
- **Disturbance of Sediment Core**
  - Mechanical disruption of sediment layers in core
- **Extraction of Sediment Core**
  - Unable to retrieve core from sampler
- **Sediment Core Retrieval**
  - Unable to retrieve sediment core through water column
- **Subsurface Debris**
  - Unable to sample through buried remnants





Courtesy Dave Richardson and Pat McGuire, Tetra Tech EC

Objectives for Sediment Sampling Activities

- ZERO Health and Safety incidences
- Core recovery of 80% or better
- Obtain sample cores in a productive and effective manner
- Retrieve undisturbed cores in rigid liners for stratigraphic profiling and chemical sampling
- Reach the underlying glacial till and/or targeted terminal depth

Sediment Coring Dataset

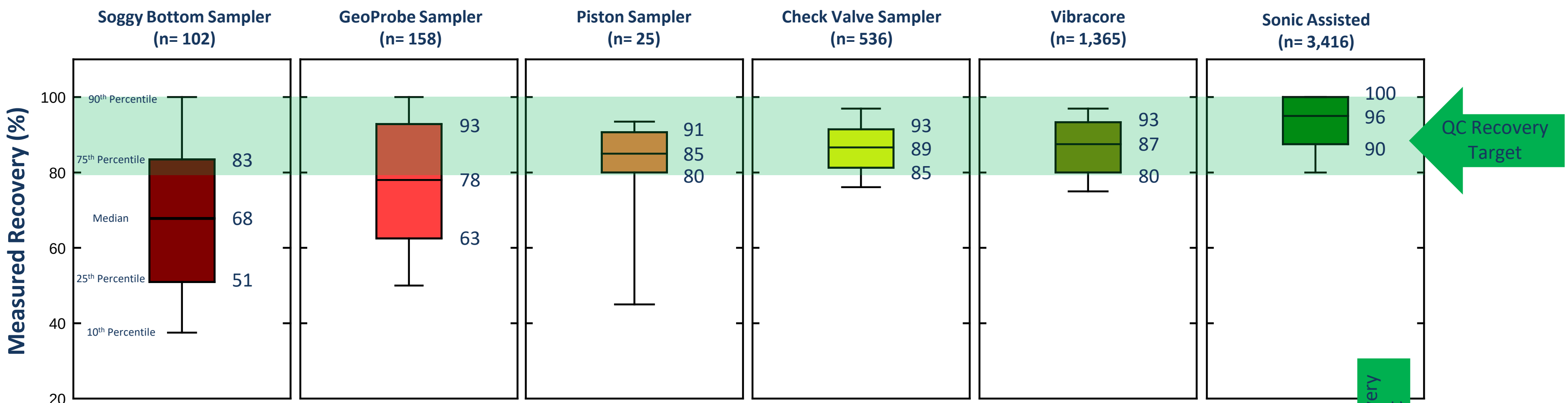
- **Cores collected from multiple sites in Midwest**
- **Cores represent broad range of sediment types/conditions**
  - Mixed organic silts to medium/coarse sands
  - Saw dust, paper mill waste, wood debris, buried logs, wood planks, coal ash
- **5,602 cores collected and evaluated from 2006 through 2016**
  - Soggy Bottom: 102 cores
  - Geoprobe: 158 cores
  - Piston: 25 cores
  - Check Valve: 536 cores
  - Vibracore: 1,365
  - Sonic: 3,416 cores

Sonic Core Sampling Summary by Major Project

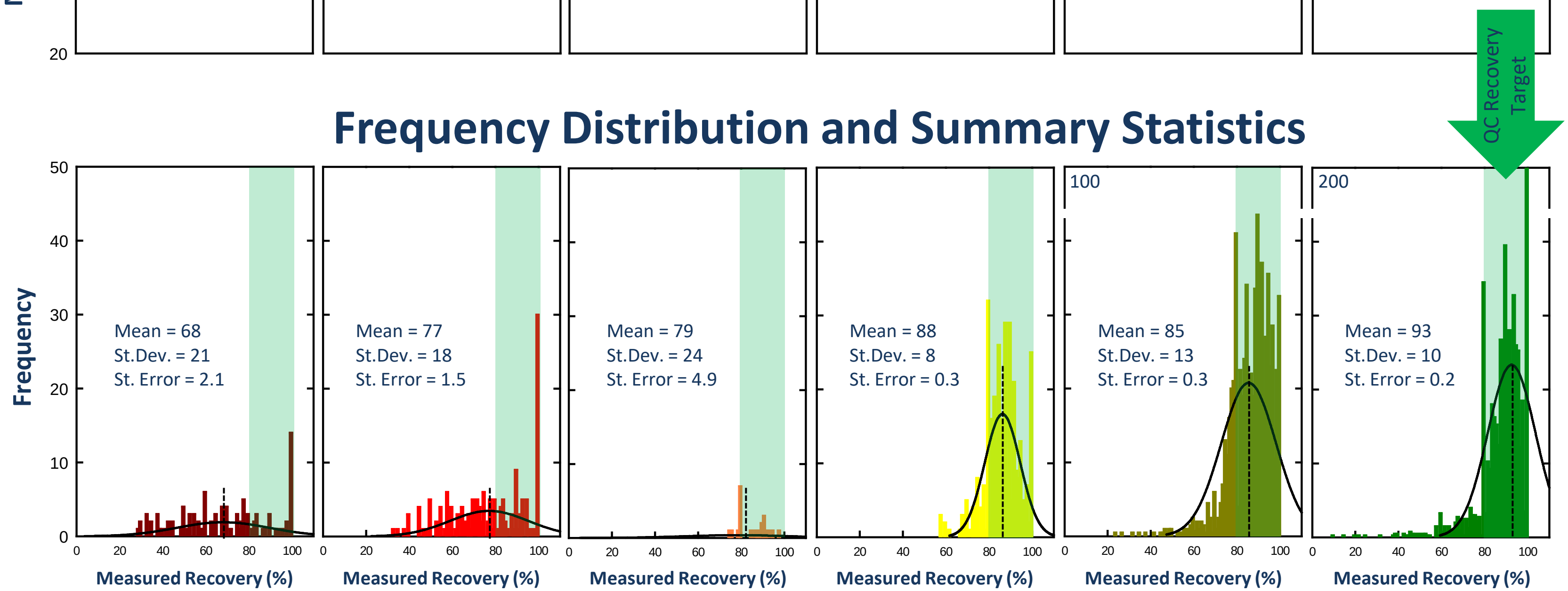
Coring Intervals	TR	LFR	MR	KR	CMS
0-5 ft	1,134	304	20	115	38
5-10 ft	549	129	20	115	38
10-15 ft	313	68	20		38
15-20 ft	192	47	20		38
20-25 ft	85	33	20		20
25-30 ft	25	20			
>30 ft	11	4			

Overall Data Summary

Tukey Box Plots

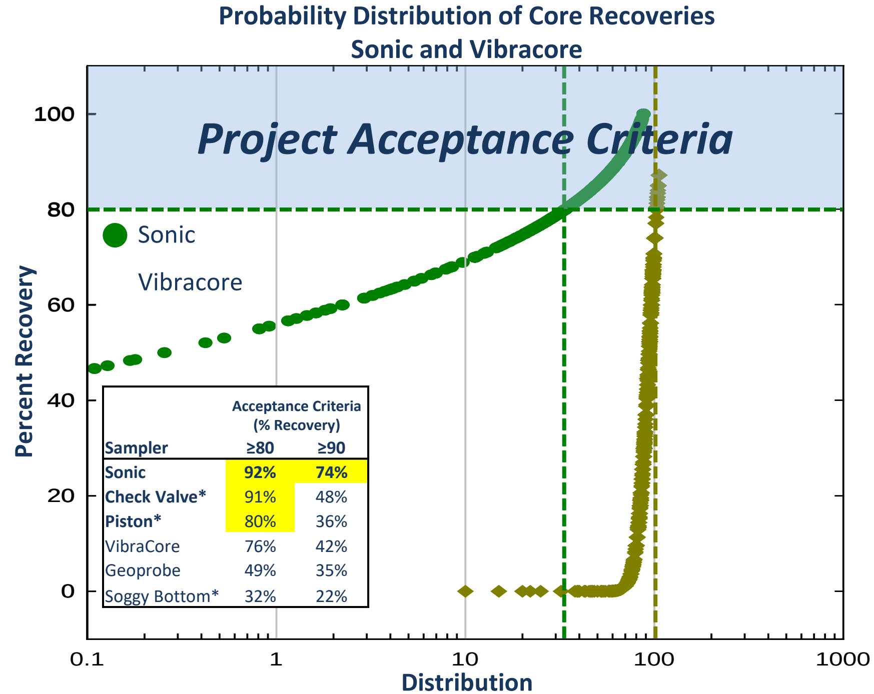


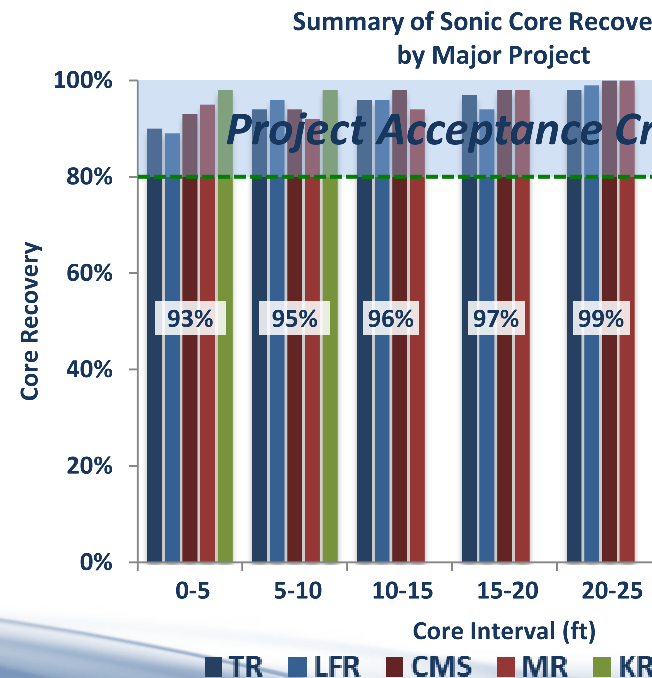
Frequency Distribution and Summary Statistics



General Observations

- Larger diameter coring devices yielded higher percent recoveries
- Sonic techniques produced higher sediment recovery, greater production rates, and more efficient for depths greater than 8 ft
- Manual sampling techniques were most efficient in terms of productivity for coring depths of 8 ft or less
- Zero Health and Safety incidences during the 2007-2016 sampling programs
- Some clients now require sonic sampling



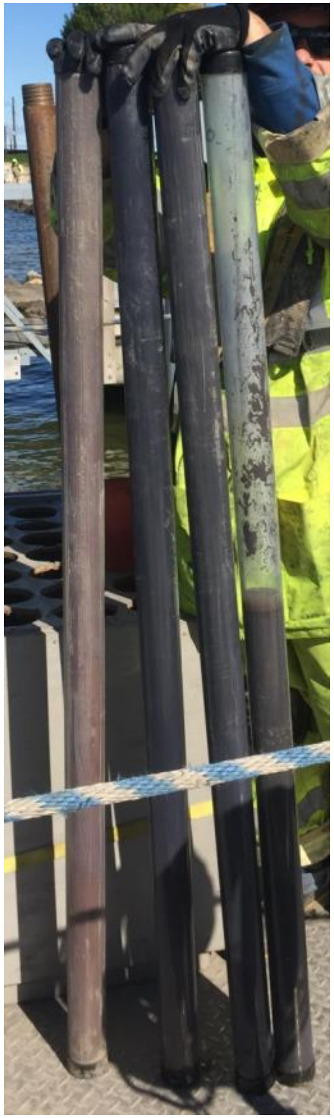


* Indicates manual sampling technique.

Benefits of Sonic Sampling

- Hydraulically advanced high frequency (200 Hz) sonic generates undisturbed sample cores
  - Continuous depths of 60 ft and diameter up to 4 inch
- Dedicated sample cores preserved in rigid tube liners (not bags)
  - Storage, inspection, physical profiling, and sample processing
- Consistently accurate core collection across wide range of materials
  - Fine grain organic silts, sands, gravels, clays, and coal ash
- No drilling fluids or cuttings
- Typically 2x-3x faster than convention methods
- Excellent recoveries (no "corrections")
  - Typically 90% or greater





ATS


River Setting


Bay on Great Lakes


Reservoir

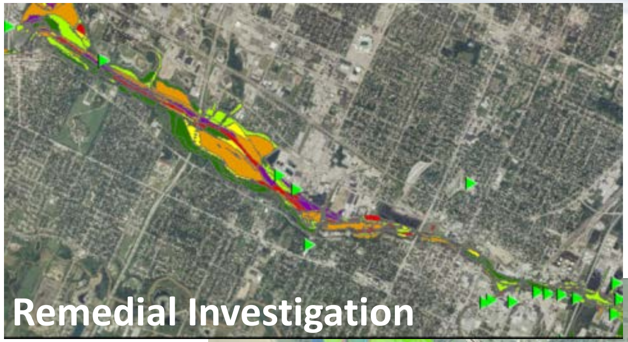

Coal Ash Pond

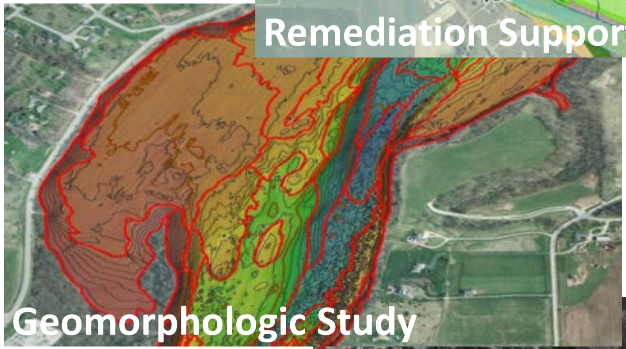
Suitable Site and Environmental Settings

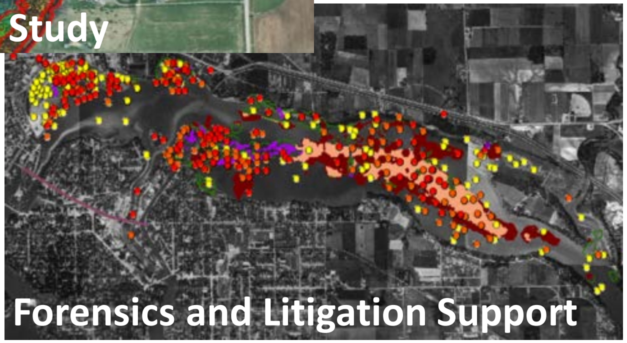
- **Streams, rivers, ponds, ash ponds, lakes, reservoirs, estuarial settings**
- **Organic silts, sands, and clay**
  - Cohesive to non-cohesive
  - Fine grain to coarse grained
  - Soft to consolidated formations
- **Buried wood and wood debris**
- **Paper pulp and saw dust**
- **Coal ash and industrial wastes**

Applicability

- Remedial Investigations
- Remediation Support
- Environmental Forensics
- Litigation Support
- Coal Ash Pond Closure
- Geomorphologic Studies
- Geotechnical Studies
- Limnology Studies
- Sediment Dating/Radioisotope Studies
- Mineral and Resource Exploration







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Questions

For Additional Information, Please Take A Look At Our Posters

Group 1 Poster Session: 01/10/2017 from 5:45-7:00 p.m.

Reconsideration of 1,4-Dioxane as an Emerging Contaminant of Interest

Peter M. Simon | Philip B. Simon | Sarah L. Stubblefield | Edward B. Paulson
Ann Arbor Technical Services, Inc. – Ann Arbor, Michigan, USA

Group 2 Poster Session: 01/11/2017 from 5:45-7:00 p.m.

Analytical Advancements in the Analysis of Alkylated PAH and Petroleum Biomarkers for Hydrocarbon Fingerprinting at Petroleum Release Sites

Peter M. Simon | Philip B. Simon | Sarah L. Stubblefield | Edward B. Paulson
Ann Arbor Technical Services, Inc. – Ann Arbor, Michigan, USA

Peter M. Simon
Ann Arbor Technical Services, Inc.
290 South Wagner Road
Ann Arbor, Michigan 48108
Tel. (734) 995-0995
email. Peter.Simon@AnnArborTechnicalServices.com
www.AnnArborTechnicalServices.com